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editorial_office@rsglobal.pl

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ANALYSIS OF DVB-T2 USAGE IN MONGOLIAN DIGITAL TELEVISION BROADCASTING

Bayarmunkh Bulten
Ph.D, Associate Professor of Mongolian National Defense University

ABSTRACT

In today's rapidly advancing world of information technology, the ability of television networks to transmit important information quickly and reliably is increasingly critical. Enhancements in broadcasting systems, such as the adoption of digital technology, have led to improved data storage and better quality of service (QoS). Modern transmission technologies, including the DVB-T2 digital television broadcasting system, have become widely implemented. This research examines the Mongolian DVB-T2 digital television system, analyzes common issues with DVB-T2 receivers (set-top boxes), and provides recommendations for their effective usage.

KEYWORDS

Digital Television, DVB-T2, DVB-T2 Usage in Mongolia, Receiver Damage

CITATION

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Introduction.

Digital television (DTV) is a broadcasting technology that transmits audio and video through digital signals, in contrast to traditional analog television, which uses analog signals. The transition to digital broadcasting has resulted in clearer images, superior sound quality, and more efficient use of bandwidth.

Key features of digital television include:

1. Better Image Quality: DTV supports standard-definition (SD), high-definition (HD), and ultra-high-definition (UHD) video formats, providing superior picture quality.
2. Improved Sound Quality: Digital audio supports surround sound, enhancing the audio experience compared to analog TV.
3. Efficient Spectrum Use: Digital signals are more efficient, enabling broadcasters to transmit multiple channels within the same frequency space that analog TV used for just one channel. This allows for additional content, such as multiple language tracks, interactive features, and secondary channels.
4. Interactive Services: DTV enables interactive features, including electronic program guides (EPG), pay-per-view services, and enhancements like video-on-demand (VoD) and digital recording.
5. Digital Signal Types:
   - Terrestrial (DVB-T, ATSC): Over-the-air broadcasts received by antennas.
   - Cable (DVB-C): Delivered through coaxial cable connections.
   - Satellite (DVB-S): Transmitted via satellite dishes.
6. Compression Technology: Video and audio signals are often compressed using standards such as MPEG-2 or MPEG-4, enabling more efficient data transmission while maintaining quality.

The transition to digital broadcasting offers a significantly improved user experience, providing more options and flexibility compared to analog television.

Mongolia's Adoption of DVB-T2 System

Mongolia has successfully completed the adoption of the DVB-T2 system, and its receivers comply with the national standard MNS 6401:2013, ensuring reliable access to digital broadcasting.

Table 1. Comparison of the Primary Digital TV Standards Used Worldwide

Feature	ATSC (Advanced Television Systems Committee)	DVB-T (Digital Video Broadcasting — Terrestrial)	ISDB-T (Integrated Services Digital Broadcasting — Terrestrial)	DTMB (Digital Terrestrial Multimedia Broadcast)
Region	North America, South Korea, Mexico, others	Europe, Australia, parts of Africa, others	Japan, Brazil, parts of South America	China, parts of Southeast Asia
Transmission	8-VSB (Vestigial Sideband Modulation)	COFDM (Coded Orthogonal Frequency-Division Multiplexing)	BST-OFDM (Band Segmented Transmission-OFDM)	TDS-OFDM (Time Domain Synchronous-OFDM)
Resolution	Up to 1080i, 720p	Up to 1080p	Up to 1080i	Up to 1080p
Audio	Dolby Digital (AC-3)	MPEG-2, Dolby Digital (AC-3), AAC	MPEG-2, MPEG-4 AAC	MPEG-2, MPEG-4 AAC, Dolby Digital (AC-3)
Bandwidth	6 MHz	6, 7, or 8 MHz	6 MHz	8 MHz

This table offers a clear comparison of the primary digital TV standards used worldwide, highlighting key features and regional adoption.

Out of the 36 countries in the Asia-Pacific region, most have adopted or are planning to adopt digital television systems. Specifically, digital TV systems are either in place or planned in all these countries, totaling 36.

Digital television systems are well-established across the region, with DVB-T2 being the most widely adopted standard due to its efficiency and capacity for high-definition broadcasts. Other standards like ISDB-T and ATSC are used in specific countries based on technological and regulatory preferences. Adoption dates can vary depending on government policies, technological readiness, and infrastructure development.

Table 2. Overview of the Digital Television Systems Adopted by Each Country and the Corresponding Adoption Years

Country	Digital TV System	Adoption Year
China	DTMB	2006
Japan	ISDB-T	2003
South Korea	ATSC	Early 2000s
Philippines	ISDB-T	2010
Singapore	DVB-T2	2013
Thailand	DVB-T2	2014
India	DVB-T2	Starting around 2012
Australia	DVB-T	2001
Mongolia	DVB-T2	2014

This table provides an overview of the digital television systems adopted by each country and the corresponding adoption years, where available. Mongolia adopted the DVB-T2 system in July 2014.

Table 3. References to Confirm the Digital Television Systems Adopted in Each Country within the Asia-Pacific Region

Country	Digital TV System	Reference
China	DTMB	Wikipedia: DTMB
Japan	ISDB-T	Wikipedia: ISDB
Mongolia	DVB-T2	Wikipedia: DVB-T2
North Korea	DVB-T2	NK News
South Korea	ATSC	Wikipedia: ATSC
Taiwan	DVB-T	Wikipedia: DVB-T
Brunei	DVB-T2	Brunei Times
Cambodia	DVB-T2	Asian Development Bank
Indonesia	DVB-T2	Asia-Pacific Broadcasting Union
Laos	DVB-T2	ITU Report
Malaysia	DVB-T2	The Star
Myanmar	DVB-T2	Global New Light of Myanmar
Philippines	ISDB-T	Wikipedia: ISDB
Singapore	DVB-T2	Infocomm Media Development Authority
Thailand	DVB-T2	Bangkok Post
Timor-Leste	DVB-T2	Timor-Leste Government
Vietnam	DVB-T2	VietNamNet
Afghanistan	DVB-T2 (planned)	Deutsche Welle
Bangladesh	DVB-T2	Dhaka Tribune
Bhutan	DVB-T2	Kuensel
India	DVB-T2	The Economic Times
Maldives	DVB-T2	Raajje MV
Nepal	DVB-T2	Nepal Republic Media
Pakistan	DVB-T2 (planned)	Pakistan Electronic Media Regulatory Authority
Sri Lanka	DVB-T2	Daily FT
Australia	DVB-T	Australian Government
Fiji	DVB-T2	Fiji Broadcasting Corporation
Kiribati	DVB-T2	Radio New Zealand
Marshall Islands	DVB-T2	ITU Report
Micronesia	DVB-T2 (planned)	ITU Report
Nauru	DVB-T2	Nauru Government
New Zealand	DVB-T	New Zealand Government
Palau	DVB-T2	Radio New Zealand
Papua New Guinea	DVB-T2	Post Courier
Samoa	DVB-T2	Samoa Observer
Solomon Islands	DVB-T2	Solomon Times
Tonga	DVB-T2	Matangi Tonga
Tuvalu	DVB-T2	Tuvalu Government
Vanuatu	DVB-T2	Radio New Zealand

This table includes references that confirm the digital television systems adopted in each country within the Asia-Pacific region.

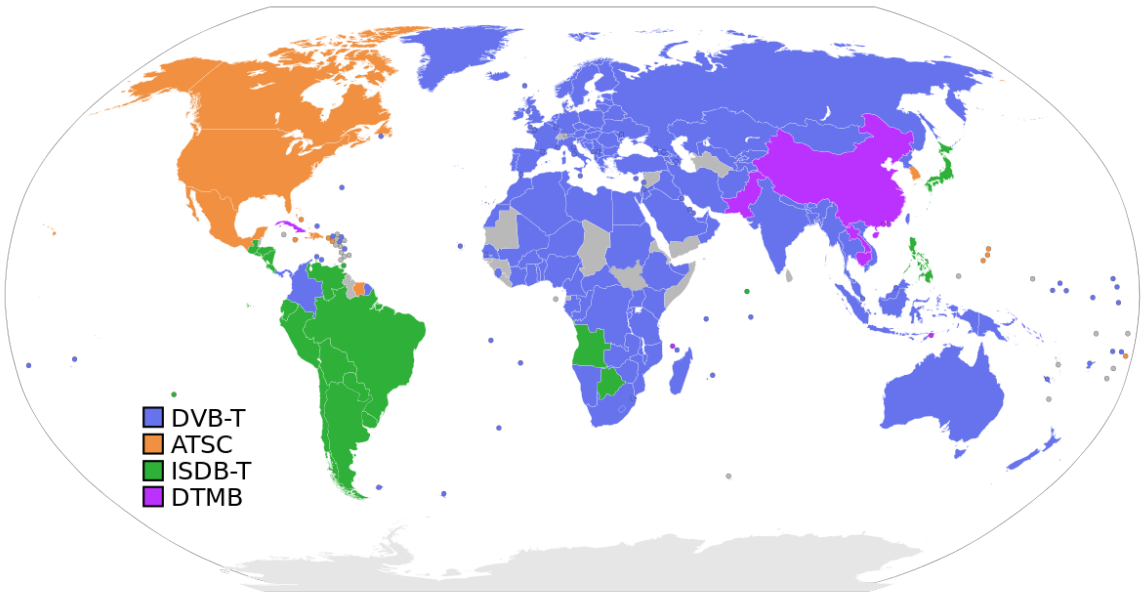

Fig. 1. Map of Digital Terrestrial Television Broadcasting Systems by Country

Digital Video Broadcasting — Terrestrial (DVB-T) standards have evolved over the years to improve performance and capabilities. There are three primary DVB-T standards:

1. DVB-T (DVB-T1): The original standard, introduced in 1997. It uses COFDM (Coded Orthogonal Frequency Division Multiplexing) modulation and supports both SD and HD video. While offering robust reception, it has relatively lower spectral efficiency compared to its successors.
2. DVB-T2: The second generation, introduced in 2009. It provides significant improvements over DVB-T, including higher data rates, better robustness, and improved spectral efficiency. DVB-T2 uses a more advanced modulation scheme (256-QAM compared to DVB-T's 64-QAM) and includes features like MISO (Multiple Input Single Output) to enhance signal quality and coverage.
3. DVB-T2-Lite: A subset of DVB-T2, designed for mobile and portable reception. It offers reduced complexity and power consumption, making it suitable for devices like smartphones and tablets. DVB-T2-Lite sacrifices some data rate capabilities to achieve these benefits.

These standards reflect the ongoing development of terrestrial digital broadcasting technology, with each generation bringing advancements in efficiency, quality, and usability.

Table 4. Key Strengths and Weaknesses of Each Digital TV Standard

Standard	Advantages	Disadvantages
DVB-T	Widely adopted in Europe, Australia, and parts of Asia. Good spectral efficiency. Supports multiple resolutions and channels.	Limited support for mobile reception. Lower data rates compared to newer standards. Less robust error correction.
DVB-T2	Higher spectral efficiency and data rates. Improved robustness and coverage. Support for Multiple PLPs (Physical Layer Pipes). Enhanced mobile reception with DVB-T2-Lite.	More complex and expensive to implement than DVB-T. Requires new receiver equipment for consumers.
ATSC	High data rate within 6 MHz channels. Strong presence in North America and South Korea. Efficient for high-definition broadcasting.	Limited support for mobile reception. Less robust in multipath environments compared to COFDM. Less flexibility in channel bandwidth.
ISDB-T	Robust mobile reception with 1seg. Flexibility in channel configurations. Good error correction and interactivity features. Widely used in Japan, Brazil, and the Philippines.	More complex receiver design. Higher implementation costs. Limited adoption outside of specific regions.
DTMB	Good spectral efficiency. Supports both fixed and mobile reception. High data rates. Widely used in China.	Limited global adoption. Requires specific receiver equipment. Implementation complexity.

This table outlines the key strengths and weaknesses of each digital TV standard, highlighting why different regions have adopted different standards based on their unique requirements and technological capabilities.

Table 5. Key Differences Between DVB-T, DVB-T2, and DVB-T2 Lite Standards

Feature	DVB-T	DVB-T2	DVB-T2 Lite
Year of Introduction	2003	2008	2011
Modulation	QPSK, 16-QAM	QPSK, 16-QAM, 64-QAM, 256-QAM	QPSK, 16-QAM, 64-QAM, 256-QAM
FEC (Forward Error Correction)	Convolutional coding	LDPC coding	LDPC coding
Bandwidth	6, 7, or 8 MHz	1.7, 5, 6, 7, or 8 MHz	1.7, 5, 6, 7, or 8 MHz
Guard Interval	1/4, 1/8, 1/16, 1/32	1/4, 19/256, 1/8, 19/128, 1/16, 1/32, 1/128	1/4, 19/256, 1/8, 19/128, 1/16, 1/32, 1/128
MIMO Support	No	Yes	Yes
Multiple PLPs Support	No	Yes	Yes
Efficiency	Lower	Higher	Lower
Capacity	Lower	Higher	Lower
Compatibility	Backward compatible with DVB-H	Not backward compatible with DVB-T	Not backward compatible with DVB-T

This table highlights the key distinctions among the DVB-T, DVB-T2, and DVB-T2 Lite standards. While DVB-T2 Lite is a variant of DVB-T2, it is designed to offer a cost-efficient solution for broadcasters, particularly in scenarios where spectrum availability or infrastructure costs are limiting factors.

The adoption of DVB-T2 in Mongolia was based on several technical considerations, including its enhanced capacity, efficiency, and support for advanced features such as multiple PLPs (Physical Layer Pipes) and MIMO (Multiple Input, Multiple Output), which are crucial for modern broadcasting systems.

Key Features and Processes of DVB-T2 in Broadcasting:

1. Input Signal (Source)
   - Video, Audio, and Data Sources: These signals are compressed using codecs such as MPEG-4 AVC or HEVC for video, and AAC or AC-3 for audio.
2. Multiplexing
   - Service Multiplexing (MUX): Multiple streams of audio, video, and data are combined into a single signal. DVB-T2 allows several services (TV channels, radio, or data services) to be multiplexed into one signal.
3. DVB-T2 Modulator
   - Channel Coding:
     - FEC (Forward Error Correction): Corrects errors introduced during transmission. DVB-T2 employs LDPC (Low-Density Parity Check) and BCH (Bose-Chaudhuri-Hocquenghem) codes for robust error correction.
   - OFDM (Orthogonal Frequency-Division Multiplexing): Splits the signal into multiple subcarriers, improving resistance to multipath interference.
   - Time Interleaving: Spreads data across time to make it more resistant to interference bursts.
4. Transmission (Broadcasting)
   - Modulation (COFDM): The signal is modulated using COFDM (Coded Orthogonal Frequency Division Multiplexing) and transmitted over terrestrial frequencies.
   - Transmitter: The signal is amplified and sent to transmission antennas for broadcast.
5. Reception (Receiver)
   - Antenna: The DVB-T2 signal is received through a terrestrial antenna.
   - Tuner: The signal is tuned and demodulated using the DVB-T2 standard at the receiver side.
   - Set-Top Box or Integrated TV: This device decodes the broadcast signal, demodulates the OFDM signal, and applies error correction to recover the original data.
6. Output (TV)
   - Display and Sound: The decoded video and audio are output to the TV, providing the viewer with the visual and audio experience.

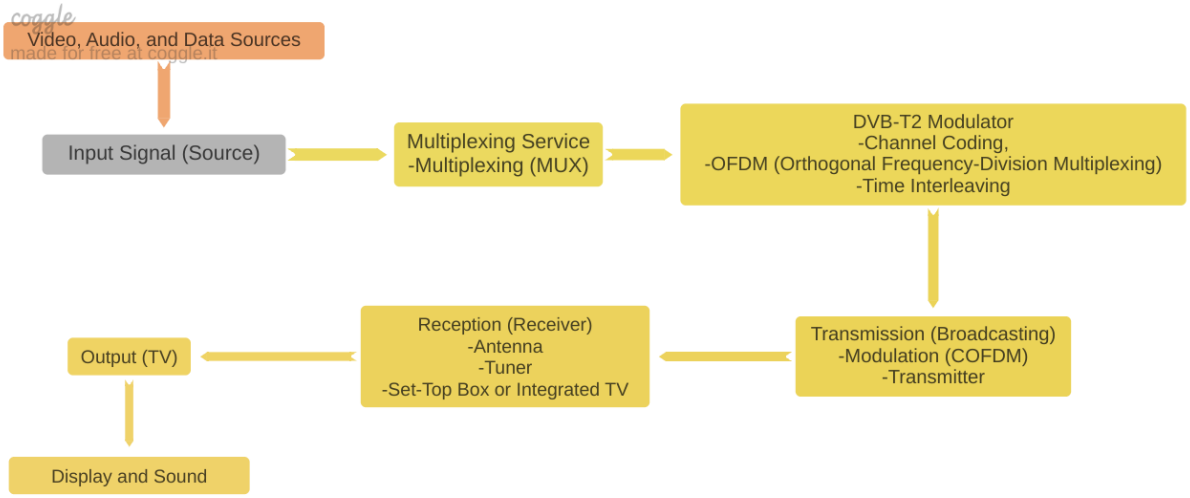

Fig. 2. Elementary Transmission Chain of DVB-T2

As Mongolia transitioned to digital technology for radio and television broadcasting, the Information Technology, Post, and Communication Agency fully adopted digital broadcasting on July 31, 2014. As part of this initiative, plans were made to install digital television retransmitters in 361 Mongolian settlements and Ulaanbaatar. Ultimately, 371 retransmitters were installed across the country, marking a significant milestone in the country's transition to digital broadcasting.

Following the adoption of digital television, Mongolia began using European DVB-T2 receivers, a widely adopted standard used by many countries around the world for digital broadcasting.

Analysis of DVB-T2 Usage in Mongolian Digital Television Broadcasting

A Comparison of DVB-T2 Users

According to a national statistical survey conducted at the end of 2023, Mongolia had 761,800 households, of which 77.5% received multi-channel television services. A survey submitted by the Mongolian National Radio and Television Network, in letter No. 407 dated September 23, 2015, indicated that 141,046 consumers in Mongolia had purchased digital television receivers (set-top boxes), with 76,759 households acquiring DVB-T2 television receivers.

Number of DVB-T2 Users

As of the most recent data, approximately 63% of Mongolian households use the DVB-T2 TV standard for digital broadcasting. With a population of around 3.3 million, this translates to approximately 2 million people having access to DVB-T2 broadcasts. This significant adoption rate reflects Mongolia's transition to digital television, providing its citizens with enhanced video and audio quality.

Table 6. Common Information Resources and Usage Trends in Mongolia

Resource	Approximate Usage (%)
DVB-T2 Television	63%
Cable Television	11%
Satellite Television	2%
Online Streaming Services	19%
Other (e.g., Radio, DVD)	5%

This table summarizes the usage trends of various information resources in Mongolia, showing a clear preference for DVB-T2 as the dominant medium for digital television broadcasting. These statistics reflect a growing preference for high-quality, reliable digital content delivery systems.

Table 7. Commonly Used Information Resources by Mongolian Users

Resource Type	Examples	Approximate Usage (%)
News Websites and Portals	News.mn, Gogo.mn, Ikon.mn	30%
Social Media Platforms	Facebook, Twitter, Instagram	25%
Online Databases and Repositories	Mongolian National Library, University Libraries	5%
Educational Platforms	Edutainment.mn, Moodle-based platforms	5%
Books and E-Books	Internom.mn, M+ App	5%
Podcasts and Webinars	Podcast.mn, YouTube	5%
Academic Journals and Articles	Mongolian Journal of International Affairs	5%
Forums and Online Communities	Asuult.net, Reddit	10%
Newsletters and Email Subscriptions	News.mn Newsletter, Gogo.mn Email Alerts	5%
Mobile Apps	Univision App, Mongol Chat	5%
Radio and TV	MNB, TV5 Mongolia, FM 103.6	10%

Notes:

- News Websites and Portals: These sites are the primary sources of daily news for Mongolian users.
- Social Media Platforms: Facebook dominates as a major platform for news and community engagement.
- Forums and Online Communities: Local forums like Asuult.net are highly influential in online discussions.
- Radio and TV: Despite the growth of online media, traditional media such as radio and TV remain significant sources of information in Mongolia.

Research on the Usage of DVB-T2 Receivers (Set-Top Boxes) in Mongolia

The DVB-T2 receiver enables users to access digital television broadcasts on their analog televisions without requiring complex setup, technical skills, or prior knowledge. This makes it an easy solution for a wide range of users.

In Mongolia, there are 33 companies that import DVB-T2 receivers for local use. These receivers are sourced from countries such as Taiwan, China, and Switzerland and are distributed by Mongolian organizations, including DiDish LLC, MRATN, NBC LLC, and MNBC LLC.

A 2015 survey revealed that there were 217,835 digital television users in Mongolia. Of these, 76,759 households used televisions equipped with the DVB-T2 standard, while 141,076 households relied on set-top boxes to access DVB-T2 broadcasts.

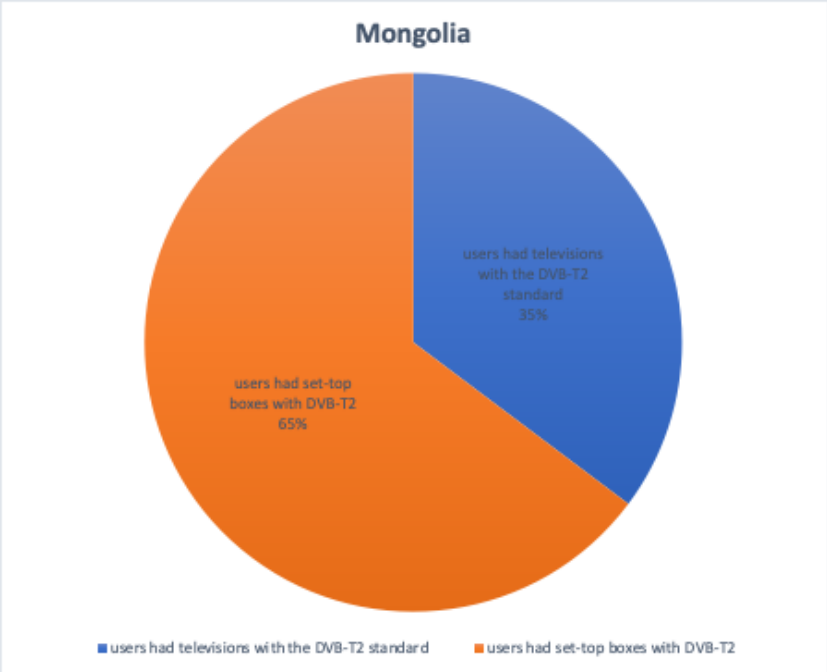

Fig. 3. Comparison of DVB-T2 Users in Mongolia

A survey conducted on January 20, 2016, by distributor organizations revealed that 141,076 set-top boxes were sold in Mongolia.

Table 8. Number of Set-Top Boxes Used in Ulaanbaatar City

Source of Purchase	Number of Set-Top Boxes
Purchased from the Mongolian National Radio and Television Network	43,513 set-top boxes
Purchased from Other Distributors	77,356 set-top boxes
Total Purchases	120,869 set-top boxes

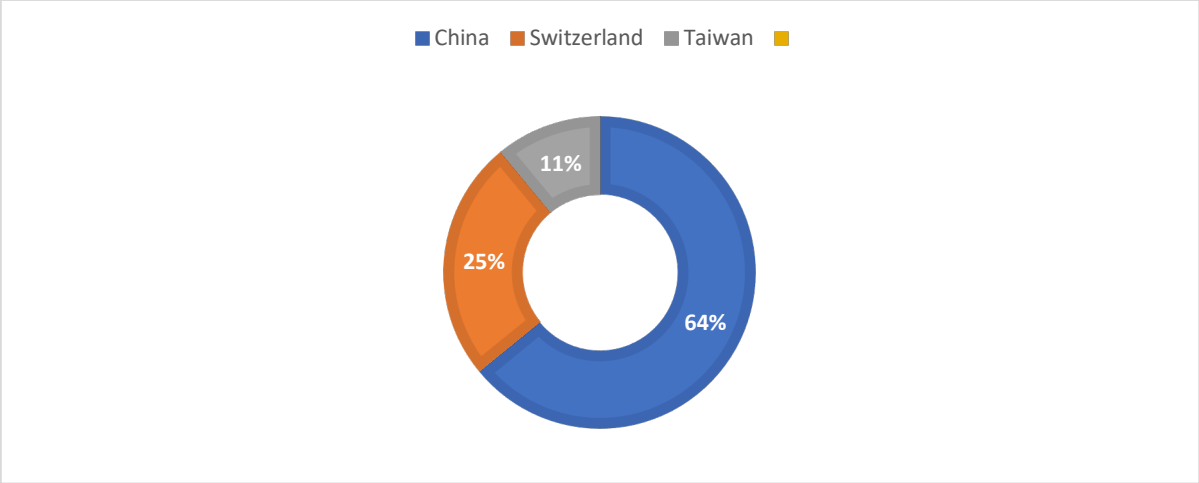

Fig. 4. Comparison of Imported Set-Top Receivers by Country of Origin for Mongolia

Research from the Measurement and Repair Center of the Mongolian National Radio and Television Network indicates that two out of three service calls are related to receivers imported from China and Taiwan. These receivers are more affordable compared to others, but their technical components tend to have a shorter lifespan.

Receivers with the Solsat and TV-Box brands are commonly used in Mongolia.

Table 9. Comparison of Solsat VS-022 and TV-Box Receivers

Specification	Solsat VS-022	TV-Box
Model	VS-022	TV-Box
Frequency Band	170–230 MHz, 470–860 MHz	170–230 MHz, 470–860 MHz
Language Options	English, Russian, Vietnamese	English, Chinese
Resolution (Pixels)	1080i, 1080p (50 Hz), 576i, 576p, 720p	1080i, 1080p (50 Hz), 576i, 576p, 720p
Display Aspect Ratio	16:9, 4:3	16:9, 4:3
Bandwidth	7 MHz, 8 MHz	6 MHz, 7 MHz, 8 MHz
Antenna Input Sensitivity (Min)	-79 dBm	-78 dBm
Connectivity	HDMI, A/V Output	HDMI, A/V Output
TV Standard	PAL, NTSC	PAL, NTSC
Other Features	Parental Lock, USB Configuration	Parental Lock, USB Configuration

Receiver Damage Analysis in DVB-T2 Systems

In 2023, the Mongolian National Radio and Television Network received a total of 384 complaints, of which 329 were related to service calls. The table below outlines the causes of these service complaints.

Table 10. Causes of Service Complaints Received by the Mongolian National Radio and Television Network (2023)

Number	Cause of Complaint	Total
1	Can't find channels/settings	61
2	Issues with set-top box	78
3	Damages, delays, and inspections	127
4	Studio and Monsat broadcasting breaks	6
5	Natural difficulties (e.g., solar influence)	31
6	Actions by external parties or organizations	8
7	Other complaints	11
8	Temperature issues in site buildings	6
9	Software development	1
Total	Total Complaints	329

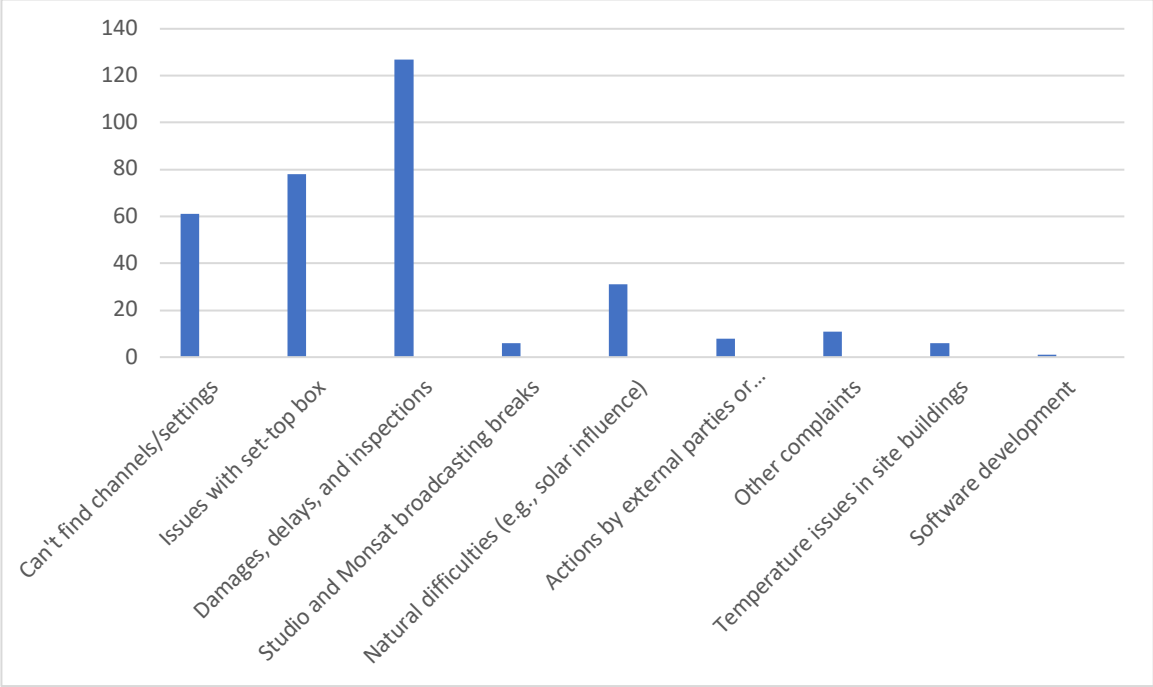

Fig 5. Causes of Service Complaints Received by the Mongolian National Radio and Television Network (2023)

The table below shows distribution of complaints.

Table 11. Distribution of Complaints Related to DVB-T2 Broadcasting and Set-Top Boxes

Complaint Type	Total
Television broadcasting is not working, and signal is not available	268
Some television channels are missing	11
Others (general complaints)	4
Set-top box settings are incorrect	46
Total	329

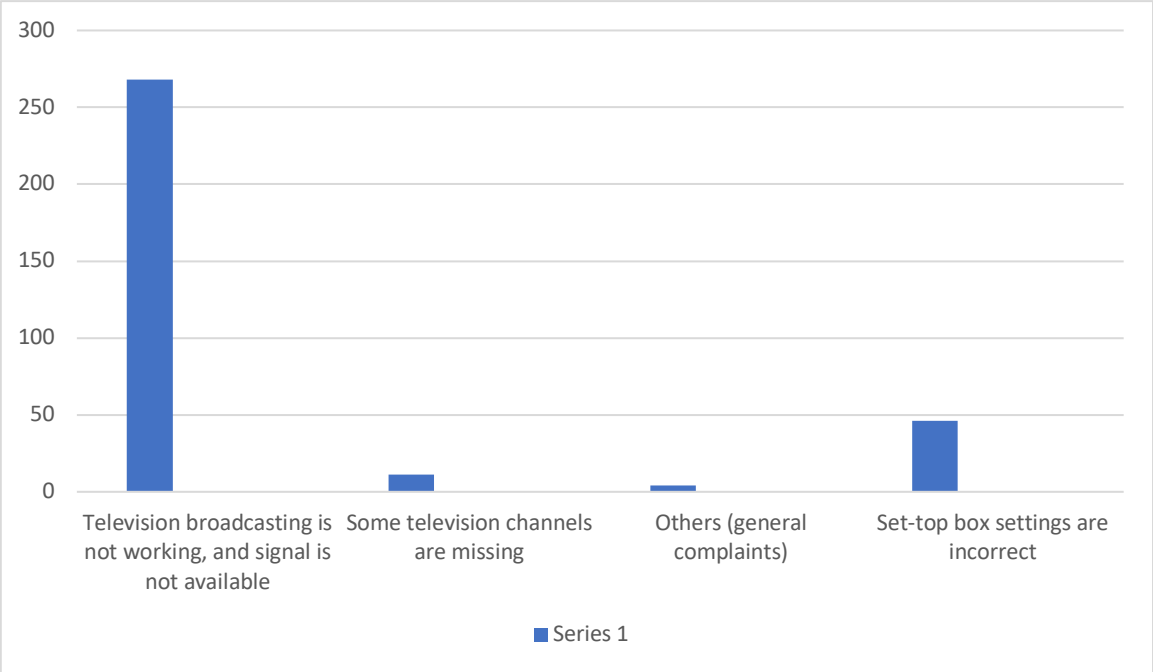

Fig. 6. Distribution of Complaints Related to DVB-T2 Broadcasting and Set-Top Boxes

Common Damages Observed in Set-Top Boxes

1. Damaged Capacitors in Set-Top Boxes

Damaged capacitors are one of the most frequently reported issues in DVB-T2 receivers. The causes of capacitor damage include:

- Voltage fluctuations that can lead to overheating and burning of components.
- Power supply block issues, where unstable power input contributes to capacitor damage.
- Input contamination, such as dust or moisture, which can compromise the functionality of capacitors.
- Incorrect user handling (e.g., connecting to improper voltage sources or not following manufacturer guidelines).
- Excessive heat, which accelerates the degradation of capacitors over time.

Below is an image illustrating a damaged capacitor compared to a normally functioning one:

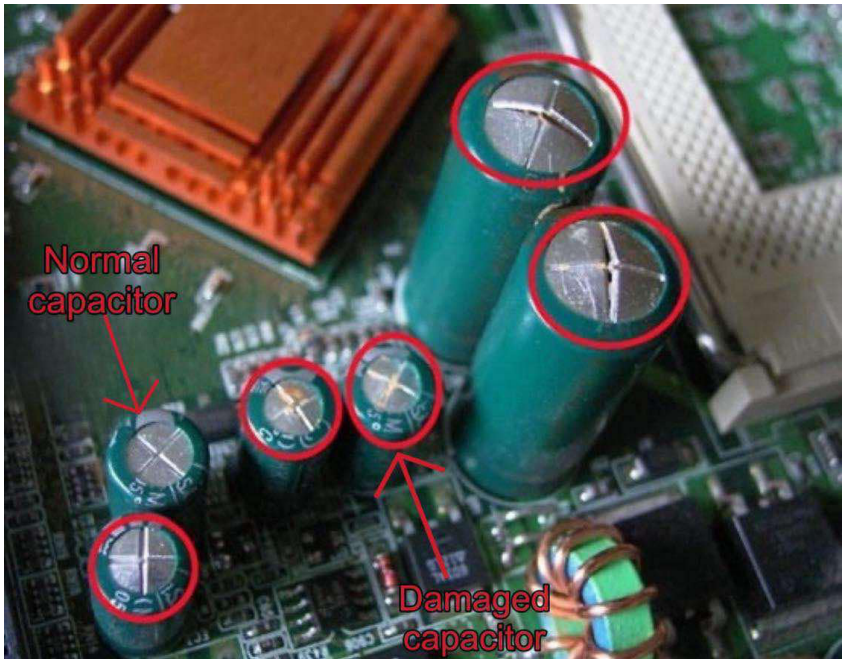

Fig. 7. Damaged capacitor and a normal capacitor

2. Damaged Control Key Buttons

Fig. 8. Control buttons

Damaged control key buttons in set-top boxes are another common issue, and their causes include both user handling and manufacturing defects. Specifically:

- Improper user handling, such as pressing the wrong buttons, can lead to internal circuit malfunctions.
- Manufacturing defects may contribute to poor durability of the buttons, making them prone to wear and tear.
- Lack of user knowledge, especially in rural areas, contributes to mishandling. Many users are unaware of the proper functioning and operation of DVB-T2 receivers, which results in improper use of the remote control and set-top box buttons.
- Environmental factors also play a significant role.
  - Uneven surfaces where set-top boxes are placed can damage the internal components.
  - Accidental drops from heights can cause physical damage to the buttons or motherboard.
  - Exposure to water or moisture from nearby sources can affect both the buttons and the internal electronics.
  - Mishandling during relocation of devices can lead to physical wear on control buttons, especially if they are not transported securely.

Table 12. Recommendations for Proper DVB-T2 Receiver Usage

Category	**Recommendation**
Main Power	Use AC 90-250V, 50/60Hz power supply.
Cable	Always use standardized coaxial cables that meet recommended specifications to avoid damage to the receiver.
Location	Place the receiver in a location protected from direct sunlight, thunderstorms, and electrical sources. Ensure stability and immobility to prevent damage.
Cleaning	Unplug the receiver before cleaning. Wipe with a clean, slightly damp cloth and avoid using any cleaning chemicals.
Voltage	Avoid overloading wall outlets and extension sockets. Ensure the receiver is connected to a compatible socket to prevent overheating and electrical issues.
Ventilation	Ensure proper ventilation by keeping cooling vents unobstructed. Place the receiver on a flat surface, away from heat sources, and avoid placing items on top.
Liquid	Keep the receiver away from liquids to prevent spills or moisture, which could cause electrical damage or short circuits.
Dust & Debris	Protect the receiver from dust and debris that could enter through ventilation openings and cause malfunctions. Keep the area clean and dust-free.
Additions	Do not connect unapproved or uncertified external devices to the receiver, as they may cause damage or performance issues.
Connection	Always unplug the receiver before connecting or disconnecting cables to prevent damage.
Maintenance	Do not attempt repairs yourself. Contact a qualified expert for maintenance or repairs to avoid further damage or voiding the warranty.

Conclusions

1. Expansion of TV Access: The widespread use of Cable TV and IPTV in Ulaanbaatar and rural areas has significantly increased access to multichannel television across Mongolia, enabling reception of television signals regardless of geographic location.

2. Rising Demand for Receivers: The growing demand for DVB-T2 receivers reflects the rapid expansion of the overall television audience in Mongolia, highlighting a substantial shift towards digital television.

3. Potential for Future Growth: Surveys from both users and organizations indicate that further development of network infrastructures, improvements in service arrangements, and the adoption of updated technology will be crucial for the ongoing growth of Mongolia's radio and television sector. The transition to a digital system promises significant benefits.

4. Installation of Retransmitters: Plans to install digital television retransmitters in 361 Mongolian settlements and Ulaanbaatar have led to the successful installation of 371 retransmitters nationwide. However, additional efforts are required to ensure a fully functional digital television system across all settlements.

5. Importance of Television for Rural Areas: Television broadcasting has become an essential tool in meeting the information needs of rural workers and herders, especially given Mongolia's vast territory and reliance on semi-wild livestock.

6. Growth in TV Viewership: A comprehensive survey conducted across 21 provinces, 9 districts of Ulaanbaatar, and 360 soums revealed a significant increase in television viewers. This growth has driven a corresponding demand for DVB-T2 receivers.

Receiver Damage and Solutions: In 2023, the National Radio and Television Network of Mongolia received 127 complaints related to damages, delays, and inspections, with 80% of these complaints focused on issues with receiver capacitors and control buttons. To address these problems, recommendations for proper DVB-T2 receiver usage have been developed, which could greatly reduce complaints and damage. Additionally, ensuring that digital receivers are sold alongside these recommendations could help minimize future issues and extend the lifespan of the devices.

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